IN THE SPECIFICATION:

Page 5, second paragraph and seventh paragraph (that continues to page 6), respectively, REPLACE as follows:

A1

Figure 1(b) depicts the time domain of Figure 1(a) with the added ~~guar period~~ **guard-period** containing a cyclic prefix

A2

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

In Figure 1(a), multi-carriers 10 are modulated such that carrier spacing is carefully selected whereby each sub-carrier is orthogonal to other sub-carriers. In OFDM, the entire available bandwidth B is divided into a number of points ~~K = fk, ...fn~~ **K = $f_1, \ldots, f_K$,** where adjacent points are ~~or~~ separated by a frequency band $f_s = \Delta f$, such that $B = K\ \Delta f$. In Figure 1(b), 543 K points are grouped into a frame 1 or frame 2 of K_1 points and two tail slots of K_2 points each, such that $K = K_1 + 2K_2$ and t_s is the useful symbol period. The frame carries the information intended for transmission under the form of Differential Phase-Shift Keying (DPSK) symbols or Quadrature Amplitude Modulated (QAM) symbols. Thus, each point in the frame corresponds to one information symbol. The two tail slots act as guard bands 11. The total symbol duration is $T = T_G + t_s$ where T_G is the guard interval and t_s is the useful symbol duration. The ratio of the guard interval to the useful symbol duration is application dependent. The insertion of guard interval ~~will reduce data throughput~~, T_G, **which is** usually less than $T/4$ **will reduce data throughput**. Although not shown in the Figure, the symbols are overlapped in the frequency domain but are separated by the guard interval in the time domain. A digital communication system using OFDM is described in USP 5,841, 813 issued November 24, 1998, assigned to the assignee of the present invention and fully incorporated herein by reference.

Page 6, second paragraph and third paragraph (that continues to page 7), REPLACE as follows:

A2 Cont.

Turning to Figure 2(a), an IBOC system 12, as generally described in USP 5757854 and 5850415, includes a transmitter 14 coupled through an antenna 15 and an RF amplifier- down converter- filter 16 **in** ~~to~~ a receiver 18 using OFDM as previously described in connection with Figures 1(a) and (b). The transmitter uses cyclic prefix or guard rings which determine OFDM frame boundaries for frame synchronization. Both the transmitter 14 and the receiver 18 include a clock (not shown). When there is a difference in the clock frequencies at the transmitter and receiver, there are two problems. First the difference causes an uncertainty in frame synchronization. Second, there may be frequency offset between the local oscillator and the transmitter and the local oscillator and ~~this~~ **the** receiver which causes sampling errors of the same amount in the frequency domain. The result is an increased Bit Error Rate (BER) with significant data errors at the receiver. A feature of the invention is an IBOC system which corrects the problems of frame synchronization and frequency offset. An OFDM system, unlike well-known binary FM systems, does not explicitly provide bit timing information and, as such, does not lend itself to conventional clock derivation techniques. However, the present invention provides a way to derive a clock that is phase coherent with the transmitter which can be used at different points in the receiver.

An rf modulated signal 17 is received at the receiver 18 and processed in accordance with OFDM. The signal 17 is recovered as an In Phase component (I) and a Quadrature Phase component (Q) of a baseband signal 20 by the unit 16. The I and Q outputs are each provided to standard analog-to-digital converters 24^1 and 24^2, respectively responsive to receiver sampling

clocks 26^1 and 26^2, respectively. The (I) and (Q) components of the received signal are each sampled in the ~~converter s~~ **<u>converters</u>** at 544 points using the receiver sampling clocks. The output of the converter 24 is provided to a standard 2-frame FIFO 28 which then feeds into an offset correcting circuit 30 and a correlator 32. Starting from the first sample in the FIFO 28, a complex auto-correlation function R_i of the I and Q components of the received symbol is computed for $i = 0,1,\ldots,543$ in the following way. Let z_k be the received $k-th$ sample

A8 Cont.

$$z_k = x_{I,k} + jx_{Q,k}$$

where $x_{I,k}$ and $x_{Q,k}$ are, respectively, the I and Q components of the received sample. Then

$$R_i = \sum_{k=i}^{i+31} z_k z_{k+512}^*$$

where z_k^* is the complex conjugate of z_k. Values of R_i for L latest frames are saved in the L-frame FIFO 34. Suppose $R_i(j)$ is the value of the auto-correlation function R_i of the $j-th$ frame of that FIFO. Its average value $\overline{R}_i$ is then computed as

$$\overline{R}_i = \sum_{j=1}^{L} R_i(j).$$

The amplitude and phase components of $\overline{R}_i, i = 0,1,\ldots,543$ are provided to an OFDM frame synchronization estimator 36 and an offset estimator 38. The frame synchronization estimator 36 uses the amplitude of the auto-correlation function to estimate the frame boundary. The index at which the amplitude of $\overline{R}_i$ is maximum for all i with $i = 0,1,\ldots,543$ gives the estimated frame boundary. For each incoming frame, this index which is actually a pointer to a specific sample of that frame is provided to a digital phase-locked loop 40 which generates a sample number indicating the desired OFDM frame boundary.